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Polymer-Modified Microbial Induced Carbonate Precipitation for Stabilizing Unstable Slope Surfaces in Sri Lanka

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Abstract

Cement grouting is a widely using technique in Sri Lanka to stabilize the unstable slope surfaces. Although cement grouting has been identified as an efficient mean of stabilization, it is not an ecofriendly practice. Polymer-modified microbial induced carbonate precipitation (PM-MICP) has been recently recognized as a promising pathway to produce bio-grout material that has the potential to be used for stabilizations in the place of cement. In MICP, calcium carbonate bio-cement is produced through enzymatic reactions. The efficiency of the process can be further improved by incorporating bio-polymer. In this research, the viability of the PM-MICP to stabilize the Sri Lankan unstable slope surfaces was evaluated. Representative soil samples were collected from unstable slope areas in Matale district of Sri Lanka. *Sporosarcina pasteurii* was the ureolytic bacteria, and chitosan was the natural biopolymer used for the experiments. Laboratory scaled specimens were prepared and treated using (i) saturation and (ii) percolation methods; for different concentrations of cementation solutions (i) 0.3 mol/L and (ii) 0.5 mol/L); (i) with 0.05% and (ii) without chitosan. Bacteria culture was injected twice during the fourteen days of treatment, while the cementation solution was injected daily. After the treatment, samples were removed from the mold and subjected to a comprehensive evaluation program. Laboratory-scale model slope was also prepared and treated after 28 days of treatment, and the surface strength was determined. The samples treated with 0.5 mol/L cementation solution and polymer, exhibited a strong solidification compared with the specimens treated without polymer in both saturation and percolation methods. However, bottom of samples showed a weak solidification due to the less penetration of the bacteria and cementation solution to the bottom of the sample. In without polymer case, a weak solidification was observed for the samples treated using percolation method compared with the saturation method. Higher cementation could be achieved for the samples with 0.5 mol/L cementation solution than the sample with 0.3 mol/L. Comparatively, the surface strength was higher for the slope treated with polymer, thus the PM-MICP can be recommended as a promising alternative approach to conventional cement grouting for stabilizing the unstable slope surfaces in Sri Lanka.

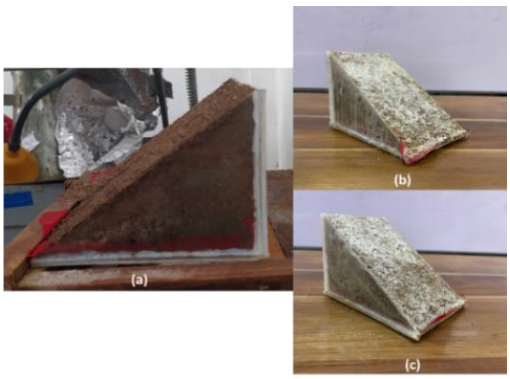

Figure 1. Laboratory scale slope model
(a) before treatment (b) treated with MICP
(c) treated with PM-MICP

Keywords: Polymer-Modified Microbial Induced Carbonate Precipitation; bio-cementation; slope stabilization; saturation method; percolation method; chitosan